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Enhancing traditional floodwater governance for inclusive and resilient flood-based livelihood systems in Tana river floodplains, Kenya

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This paper analyses the effectiveness of traditional water governance in Flood-based Livelihood Systems (FBLS), which harness floods that could have caused environmental degradation. Ostrom's Governing the Commons Principles, widely recognized for the effective management of shared resources, is used as a framework. The paper draws from discussions with 300 farmers and pastoralists in Tana River FBLS, the oldest traditional system in Kenya. The traditional floodwater governance does not satisfy Ostrom's Principles and livelihood needs. Small-scale farmers and pastoralists frequently experience floodwater scarcity while large-scale farmers use excessive floods often causing waterlogging. This floodwater sharing disparity generates conflicts and threatens small-scale farmers' and pastoralists' livelihoods. Large-scale farmers are primarily concerned with inadequate floodwater management infrastructure that hampers maximizing their harvest. For increased sustainability and equity, fairer floodwater sharing systems and enforcing institutions should be introduced before infrastructural development. These lessons from Tana River can contribute to a larger livelihood potential for flood-based agriculture globally.

Keywords: effectiveness; environment; farmers; Ostrom's principles; traditional floodwater governance; water security

1. Introduction

Flood-based Livelihood Systems (FBLS) rely on harnessing temporary floods and spreading and managing them in low-lying irrigation areas. They cover about 25 million ha across Africa and Asia where food can be grown by about 50 million smallholder farmers, irrigating on average 0.5 ha (Puertas *et al.* 2015). There are four types of FBLS: (a) floodplain agriculture (flood recession and flood rise): cultivation of flood plains, using either receding or rising floodwater or both; (b) spate irrigation: diversion and management of short duration flood flows from seasonal or ephemeral rivers; (c) flood inundation canals: canals fed by temporarily high-water levels in rivers to irrigate adjacent low-lying land; and (d) depression agriculture: shallow,

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seasonally waterlogged depressions that retain sufficient moisture for dry season grazing and crop production (Puertas *et al*. 2015; Kool *et al*. 2018).

This paper focuses on flood plain agriculture and flood inundation canals, the two dominant Tana River FBLS. They are the most extensive – together covering nearly two-thirds of the estimated 25 million ha under FBLS (Puertas *et al*. 2015). Furthermore, as well-documented in the Mekong River Delta, in addition to agricultural production, flood plains provide several environmental services: they recharge groundwater, feed species-rich ephemeral wetlands, and are depositories of local biodiversity (Berg *et al*. 2017; van Steenbergen *et al*. 2010).

Despite their huge potential development impact, FBLS are neglected in most African countries, with policy, development and research attention going to perennial irrigation, or alternatively to rain-fed agriculture (van Steenbergen *et al*. 2010). Much of the limited scientific research conducted to date on FBLS (Mehari, van Steenbergen, and Schultz 2011; Gebrehiwot *et al*. 2015; Zenebe, Haile, and Mohamed 2015; Libsekal and Mehari 2020) is largely confined to *spate irrigation* and technical aspects. Some recent studies (Castelli and Bresci 2017; Castelli *et al*. 2018) have discussed floodwater management practices; but they only addressed *spate irrigation*. Moreover, they mainly focused on demonstrating that participatory approaches can sufficiently harness farmers' views and lead to suitable solutions for sustainable modernization of spate irrigation systems. They did not analyze in detail the effectiveness of traditional floodwater governance against relevant scientific frameworks such as "Governing the Commons" (Ostrom 2002). Hence, there is still some ground to be covered on the topic of floodwater governance in spate irrigation, and much more in the other types of FBLS.

The inherent uncertainty of floods in timing and volume largely defines the nature of water governance in FBLS. Unlike in perennial irrigation, water governance in FBLS does not subscribe to fixed quantities (Mehari, van Steenbergen, and Schultz 2007). It is operational in nature and describes arrangements that create some predictability in a given situation by determining the sequence and timing of irrigation through a set of water rights and rules systems (Mehari, van Steenbergen, and Schultz 2007). Although a water rights and rules system is an imperative pillar of water governance as it could, among other things, help define how floodwater is shared between various beneficiaries; it does not and cannot operate in isolation. Its potential benefits may only be realized if there is a supportive infrastructure and a dependable basin-wide institutional arrangement. For instance, as is the case in Oda and Mersa FBLS in Ethiopia, an infrastructure that facilitates distribution of floodwater to both the upstream and downstream areas as per the agreed upon water rights and rules, contributes to better realization of the expected benefits (for example higher crop yield) by all farmers (Gebreegziabher, Eyau, and Abraham 2011). On the other hand, an infrastructure that gives more floodwater control to upstream farmers often empowers these farmers to violate certain rules and excessively irrigate, thereby increasing the likelihood of downstream crop failures. This happened in Nari River FBLS in Pakistan when multiple intakes that allowed downstream farmers to abstract water directly from the river were replaced with a single upstream intake (van Steenbergen, Nawaz, and Zenebe 2016).

Coming to the institutional arrangement, this is important for several reasons, including enforcement of water rights and rules and curtailing upstream developments that could have negative downstream impacts. For example, absence of an institution representing downstream farmers in Wadi Zabid FBLS in Yemen encouraged expansion of upstream banana plantations that required huge floodwater diversion. It eventually contributed to frequent downstream crop failures (van Steenbergen, Nawaz, and Zenebe 2016). On a positive note, there are successful institutional arrangements in some FBLS (Castelli *et al*. 2018) to enforce a spatial land distribution system that allocates each farmer's irrigation fields in both upstream and downstream areas to minimize risk of crop failures.

This paper attempts to address the above discussed gap in scientific research on the topic of floodwater governance in FBLS in Africa using as a case study the 95,000 ha FBLS at the lower Tana River catchment. This is the largest single traditional system with the longest (over 400 years) history in Kenya and Africa (Pluijm 2016). It has not been subject to external interventions that affected the traditional floodwater governance practices and is therefore expected to harbor rich experiences essential for this paper. Much investment has focused on the upper Tana River catchment driven by the interest to generate hydropower electricity to major towns, including the capital Nairobi (Braslow and Cordingley 2016).

Three specific questions are at the heart of this paper: (1) how effective is the traditional floodwater governance when analyzed against the priorities set by the farmers and pastoralists?; (2) to what extent does the traditional floodwater governance satisfy Ostrom's (2002) Governing the Commons Principles, widely recognized as imperative for successful management of a common resource such as floodwater in FBLS?; and (3) what improvements, if necessary, do the farmers and pastoralists suggest to make the governance more effective? The paper also highlights the relevance of the main findings to the Kenyan Government plan to expand FBLS in Tana River county and across the country.

2. Theoretical framework

The UNDP (2016) definition of water governance – who gets what water, when and how, and who has the right to water and related services and their benefits – very much captures the essence of traditional floodwater governance in Tana River FBLS and laid the foundation for analyzing its effectiveness.

The theory "Governing the Commons" (Ostrom 2000) provides a scientific framework for detailed effectiveness analyses of the traditional floodwater governance. This theory refutes the "Tragedy of the Commons," which argues that private ownership is the "only" means of protecting limited resources from ruin or depletion. In support of the Governing the Commons, Ostrom (2002) formulated eight Principles for effective management of a common resource such as the floodwater in the Tana River FBLS. The Principles draw from extensive evidence-based documentation on how communities have successfully devised collective ways to govern their shared resource to provide for their livelihood needs. Table 1 summarizes the relevance of six of the eight Principles in guiding the analyses of the traditional floodwater governance issues the study has identified across three pillars: (1) floodwater distribution and sharing systems; (2) conflicts and conflict management; and (3) institutional arrangements.

The other two Principles are (1) *outside authorities should respect the rule-making rights of community members*: This is very much akin to the 3rd Principle (Table 1) and is hence largely redundant; and (2) *having a community leaders-led system for monitoring members' behavior*: This is important and Tana River farmers have a

Table 1. Ostrom's Governing the Commons Principles and their relevance to analyzing floodwater governance.

Ostrom's Principles	Relevance to this paper floodwater governance
1st Principle: Define the target beneficiaries and their goals and priorities	This is imperative, as the paper analyses the effectiveness of floodwater governance from the target beneficiaries' perspectives: farmers and pastoralists. Data such as the objectives and priorities set by the beneficiaries, their categories and characteristics, the location and size of their farms or grazing area and the type of infrastructure available to them was gathered
2nd Principle: Matching rules that govern use of a common resource to local priorities, needs and demands	Helped assess to what extent the floodwater sharing rules respond to the varied priorities of three categories of farmers, and the pastoralist group
3rd Principle: All likely to be affected have equal opportunity to participate in decision-making about modification or formulation of new rules	This, among others, helped analyze the process for modifying the *upstream* first rule, which the small-scale farmers believe is depriving them of floodwater as well as other improvement measures of the traditional floodwater sharing system suggested by the farmers. The *upstream* rule allows upstream farmers to irrigate as much as they want throughout the April to June major flood season
4th Principle: Use of graduated sanctions for rule violations, and 5th Principle: accessible, low-cost means for dispute resolution	Provided the criteria for assessing the strengths and weaknesses of the Council of Elders-led conflict mitigation processes operational in the study area
6th Principle: Building responsibility for governing the common resource in nested tiers from the lowest level up to the entire interconnected system	In other words, this 6th principle advocates for institutions that have basin-wide outreach. This is essential because in almost all FBLS, various users with competing needs (farmers, pastoralists, hydropower dams, among others) share intermittent basin water resources. The principle informed the data collection and analyses of the "institutional pillar" of the traditional floodwater governance system

system of village chiefs and elders that ensures members' adherence to societal norms. The farmers, however, informed that having in place basin-wide institutions (Ostrom's 6th Principle, Table 1), is more critical when it comes to fostering effective floodwater governance.

3. Materials and methods

3.1. Study area description

Tana River County, located at the Kenyan Coast (Figure 1), is inhabited by a predominantly agrarian population of over 300,000. It has hot climatic conditions with the temperature ranging from a minimum of 23 °C to a maximum of 38 °C (Government of Kenya 2017). The rainfall is erratic and spatially highly variable. It decreases from 900 mm average annual in the mountainous region upstream of Saka town to below 300 mm in the lowland Garsen sub-county area where FBLS are practiced (Figure 1). The major April to June rainfall season generates substantial floods in the upper

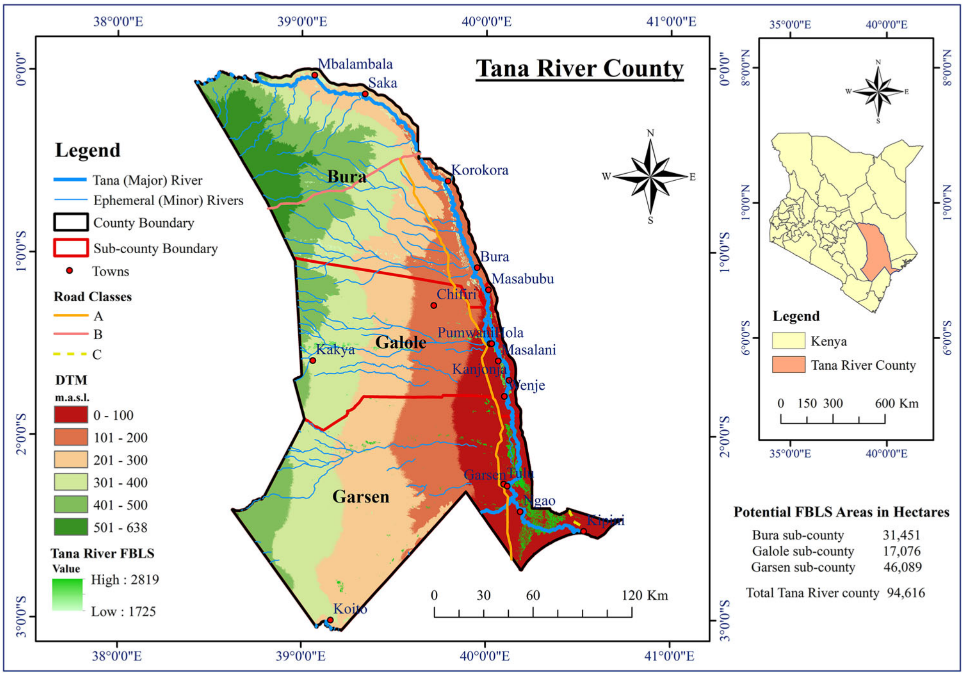

Figure 1. Location of Tana River County and FBLS potential. (Source; Own, derived using ArcGIS.)

catchment, which are harnessed in the low-lying flood irrigated alluvial plains rich with flood-deposited organic matter (Odhengo *et al*. 2014).

Tana River is the longest at 1,100 km (Geeraert *et al.* 2015) with the largest, 126,000 km^2 catchment area in Kenya (Leauthaud *et al*. 2013). From its headwaters in Mount Kenya region in the vicinity of Laikipia county some 250 km upstream of its point-of-entry to Tana River county, the river drops in elevation from 5,000 m to sea-level as it reaches the Kipini village at its mouth into the Indian Ocean. Along its course, the Tana River is fed with numerous ephemeral streams that are particularly concentrated in its downstream section where it dissects three sub-counties (Bura, Galole and Garsen) with a substantial (95,000 ha) area for FBLS (Figure 1).

Flood inundation canals and flood plain agriculture are complementarily practiced in the study area. Floods generated when the Tana River overflows its banks are harvested in adjacent main inundation canals and distributed to secondary and field canals (Figure 2). Earthen field bunds retain the floodwater in the irrigated areas where the two major crops, maize and rice, are cultivated under flood plain agriculture – flood recession and flood rise respectively.

3.2. *Methods for data and information gathering*

Field survey, Focus Group Discussions (FGDs) and individual interviews collectively gathered the necessary qualitative and quantitative data and information from about 300 representatives of the 1,850 FBLS-dependent farming and pastoral households across the nine Garsen sub-county villages (Table 2). The focal study area villages, as established during the field survey (see Section 3.2.1 below), have the longest (over

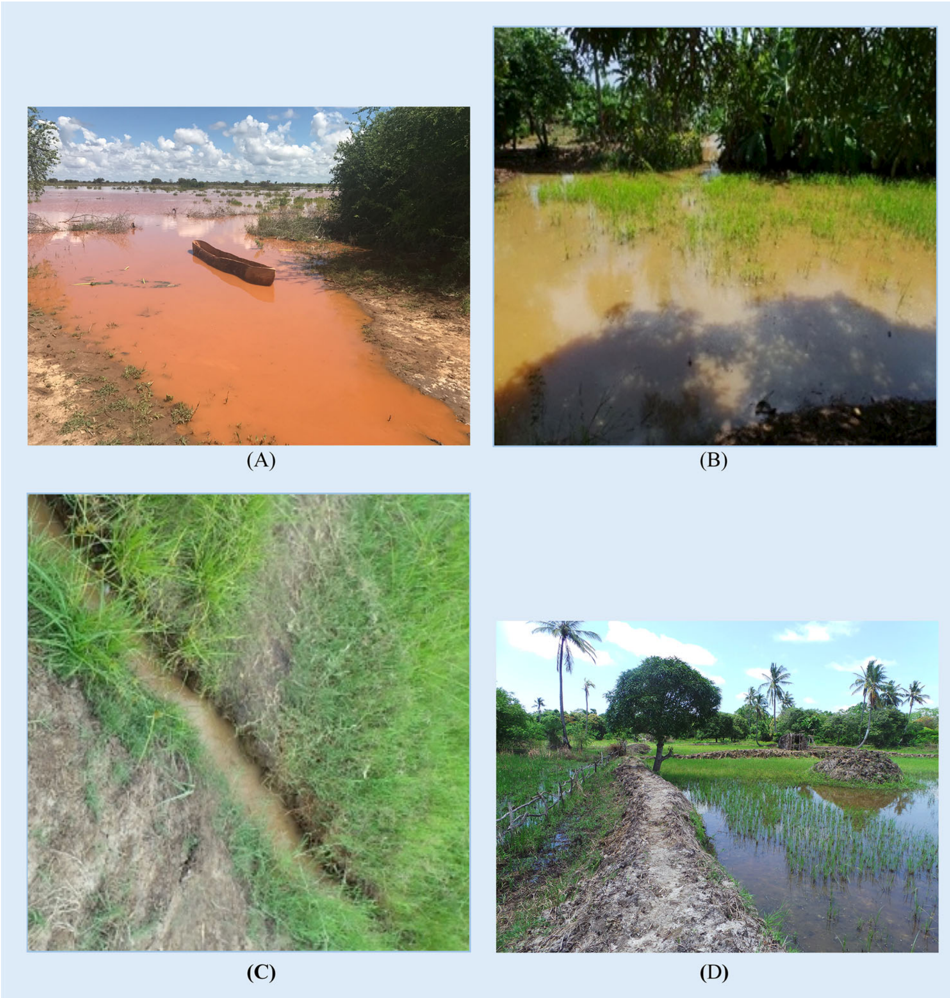

Figure 2. Some components of the Tana River FBLS canal network and infrastructure: (A) outlet to guide Tana River overflow into main canal; (B) outlet from main to secondary canal; (C) field canal; and (D) earthen field bund to retain floodwater. (Source: field survey.)

400 years) history in FBLS and traditional floodwater governance systems. According to the local Department of Agriculture and Livestock (DAL) officials, small-scale farmers irrigating less than 1.5 ha of land account for two-thirds of the 1,850 households; nearly 20% and 10% are medium and large-scale farmers cultivating 1.5 to 3 ha and larger than 3 ha respectively; the remaining 5% are pastoralists.

3.2.1. Field survey

The field survey consisted of transect walks and key informant interviews. The transect walks generated a good understanding of the canal network and floodwater management infrastructure (Figure 2). This enriched the FGD and individual interview results on how the infrastructure impacted the effectiveness of the traditional floodwater governance. The key informant interviews engaged 15 farmers and 12 representatives of

Table 2. Number of farming households of the Garsen sub-county villages with the longest history in FBLS. (Source: Garsen Department of Agriculture and Livestock database.)

No.	Village	Number of farming households*	Location of villages' irrigation fields (see Figure 1)
1	Sera	50	Upstream: close to the boundary with Galole sub-county
2	Wema	150	
3	Kilunguni	160	Midstream: immediate upstream of Garsen town
4	Maziwa	250	
5	Kilelengwani	200	Downstream: in Kipini area
6	Fejji	350	
7	Hida-baganda	300	
8	Kau	150	
9	Ozi	240	
Total	Total	1,850	

*Nearly two-thirds of the 1,850 target households are small-scale (<1.5 ha), 20% and 10% are medium-scale (1.5 to 3 ha) and large-scale (>3 ha) respectively, while 5% are pastoralists.

the DAL considered to be knowledgeable about the Tana River FBLS. These engagements produced data on population and characteristics of the target beneficiary farmers and pastoralists.

3.2.2. Focus group discussions

A total of 112 representatives of the Tana River FBLS target beneficiaries participated in fourteen focus groups: (a) three farmer leader groups: one from each upstream, midstream and downstream (Table 2 and Figure 1) irrigated areas; (b) one Council of Elders group responsible for conflict mitigation; (c) nine farmer groups: three from each of the small, medium and large-scale categories representing upstream, midstream and downstream irrigated areas; and (d) one pastoralist group. The farmer and pastoralist focus group members were selected from the DAL database of the nine villages (Table 2) using "purposive" sampling (Nyumba *et al*. 2018; Moon *et al*. 2016) to ensure engagement of those knowledgeable about traditional floodwater governance issues.

Each focus group had eight members who shared similar farming practices, priorities and challenges (Guest *et al*. 2017; Parker and Tritter 2006). These commonalities facilitated comfortable public interactions, thereby mitigating one key limitation of FGDs: non-participation of some members to avoid confrontation with others, which often leads to a consensus response that may not be the correct answer (Smithson 2000; Breen 2006). The other major limitation (Cassell and Symon 2004; Hohenthal *et al*. 2015) is that certain questions could be sensitive for a public setting and thus remain inadequately answered. This was addressed by formulating non-confrontational questions. For example: instead of directly enquiring "how do you evaluate the farmer leaders' performance?" Several indirect questions were asked: how is floodwater sharing organized? Who is responsible? Is there room for improvement?

The guiding questions were piloted to check whether: (a) women would freely speak in the presence of their male counterparts. They actively participated – there

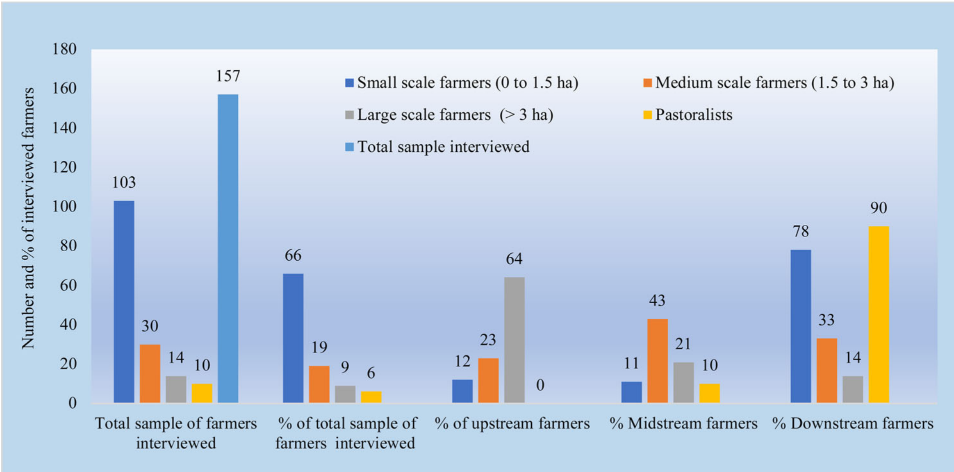

Figure 3. Breakdown of Tana River FBLS farmers who participated in the individual interviews. (Source: interview data.) Upstream, midstream and downstream refer to locations of the villages and flood irrigated areas (see Table 2 and Figure 1).

was no need for women-only groups; (b) there were unclear questions – only a few modifications were required; and (c) the farmers stayed focused for the two-hour duration and whether this time is sufficient to adequately answer the questions that were capped at twelve. There were no issues here.

3.2.3. Individual interview

Individual interview is a valuable research method to gain insight into individual perspectives (Alsaawi 2014). It was employed in this study to generate quantitative data that complements and enriches the qualitative information gathered during the FGDs. A total 157 respondents randomly selected from the nine target villages (Table 2) participated in the individual interviews: 103 small-scale, 30 medium-scale, 14 large-scale farmers and 10 pastoralists, distributed over upstream, midstream and downstream locations (Figure 3). This composition is informed by the earlier stated fact that two-thirds of the 1,850 target households are small-scale, 20% and 10% are medium and large-scale respectively, while 5% are pastoralists.

The questionnaire that guided the individual interviews covered the three pillars identified and discussed during the FGDs: (1) floodwater sharing systems; (2) conflicts and conflict management; and (3) institutional arrangements. It combined closed-ended multiple-choice questions that gathered quantitative data followed by open-ended questions that gave the respondents the opportunity to further explain their respective answers (Bryman 2012). The questionnaire was prepared with the “laddering interview technique” (Schultze and Avita 2011), an approach that facilitates gathering detailed individual perspectives on a specific issue through subsequent interconnected questions. For example, the following questions captured farmers’ perspectives on what determines the effectiveness of a floodwater sharing system: (a) can you list the effectiveness criteria in order of their importance to your situation? (b) Can you elaborate your reasons for the ranking? The questionnaire also assessed the impact of the floodwater sharing system on agricultural production and livelihoods.

3.3. Data analysis

The UNDP (2016) definition of "water governance" laid the analytical foundation while Ostrom's Governing the Commons Principles provided the theoretical framework for detailed assessment of floodwater governance issues gathered through FGDs and individual interviews (see Section 2). A thematic approach further guided the FGD data analysis. The strength of the approach lies in its flexibility to be modified for the needs of varied studies and the ability to generate detailed information (Braun and Clarke 2006). Using this approach, the three themes (pillars) were identified at the end of a three-stage process: observations during data collection; data familiarization (reading though the text and listening to audio recordings); a much deeper look at the data, a process referred to as "searching for themes" (Nowell *et al*. 2017). The analysis was consolidated by capturing the degree of conformity and divergence of views among the target focus groups (Rabiee 2004; Onwuegbuzie *et al*. 2009).

The individual interview data were analyzed using "frequency" criteria: the number and percentages of respondents who expressed a particular view or fact (Krueger and Casey 2015). The data were systematically organized and analyzed in a spreadsheet.

4. Results and discussion

4.1. Floodwater distribution and sharing system

This section discusses the Tana River farmers' flood water distribution and sharing priorities and goals (Figure 4). Defining such priorities, as articulated by Ostrom's 1st Principle, is the first imperative step for a detailed water governance effectiveness analysis.

S*mall-scale farmers* identified fair floodwater sharing rules as a top priority to achieve their main goal: sufficiently irrigate their land and obtain a good harvest when floodwater is not physically limiting. Maintaining clean canals for smooth downstream floodwater flow, mitigating conflicts and forcing upstream dam authority to stop sudden floodwater release that often damages standing crops, are also mentioned as important priorities by 54%, 34% and 31% of the farmers respectively.

The *medium-scale farmers* share the same goal as the small-scale farmers, but 57% rank a well-maintained canal network as their top priority followed by fair floodwater sharing rules (40%); conflict mitigation (23%); coordinated release of floods from upstream dams (13%); pest and disease control (10%).

The *large-scale farmers* have different goals and priorities. For them, an effective floodwater distribution and sharing system must contribute to a good harvest in both the wet (flood) and the dry (off-flood) seasons. Accordingly, the first priority for some 80% is the availability of appropriate infrastructure: well-maintained canals to efficiently divert floods to their farms; ponds and pumps to store water during the flood season for use in the dry period. At 29%, three issues make a distant second: coordinated dam floodwater release; prevention of pests and diseases; timely floodwater supply for higher quality produce.

4.1.1. Impact assessment of the traditional floodwater sharing system

The focus of impact assessment here adheres to the main tenets of Ostrom's 2nd Principle, which entails that for a floodwater sharing system to be effective, the local

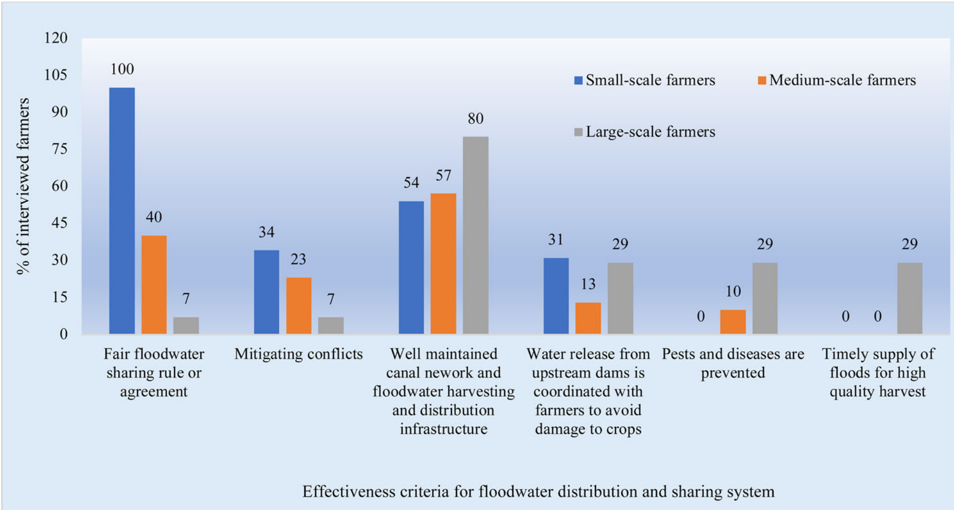

Figure 4. Tana River FBLS farmers' perspectives on what determines the effectiveness of a floodwater distribution and sharing system. (Source: interview data.)

priorities (needs and demands) of the target beneficiary groups should be adequately met.

During the flood season in the past 5 years when floodwater supply was not physically limiting, 31% of small-scale farmers were without irrigation for 2 years, 52% for 3 years, 9% for 4 years and 8% did not get floods at all. Medium-scale farmers had better access: 30%, 23% and 33% sufficiently irrigated in 4, 3 and 2 of the last 5 years respectively. Over three out of four large-scale farmers received sufficient floodwater for at least 4 of the last 5 years.

The majority (77%) of small-scale farmers cultivate downstream area whereas 67% and 85% of medium and large-scale farmers occupy the upstream and midstream sections. These farm location realities are, however, not fully responsible for the markedly varied degrees of access to floodwater (Figure 5). Only 42% of the 12 interviewed upstream small-scale farmers irrigated sufficiently in 3 of the last 5 years. Compare this to 70% of the 13 consulted medium-scale farmers who harnessed adequate floods for 4 years and throughout the 5-year period respectively. Farm location barely influences large-scale farmers' floodwater accessibility. They have financial resources to hire labor and manage large floods that would have otherwise caused damage. Moreover, within the group of farmers who share common canals, large-scale farmers have irrigation priority. They provide loans to the other farmers for crucial land preparation and farming activities, which earns them the privilege to irrigate first.

These realities indicate that the traditional floodwater sharing system does not fulfill Ostrom's 2nd Principle requirements: it does not meet the floodwater supply needs of the majority of small-scale farmers and only partially responds to the demands of the medium-scale farmers. The consequences are evident. Insufficient floodwater supply-induced frequent crop failures over the past few years have forced small-scale farmers to abandon rice cultivation, which requires a huge amount of water, and restrict themselves to growing the less water-demanding maize for subsistence. While the *upstream first rule* that gives absolute priority to large-scale farmers (see Section

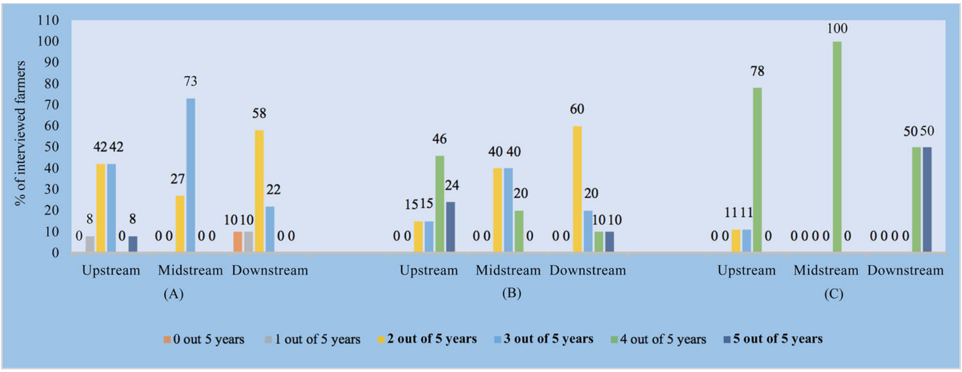

Figure 5. Number of years farmers received sufficient floodwater in the past 5 years where floodwater was not physically limiting: (A) small-scale farmers; (B) medium-scale farmers; (C) large-scale farmers. (Source: interview data.)

4.1.2) is not new, it has been more aggressively utilized in recent years, which in the view of small-scale farmers, is driven by the increasing desire among large-scale farmers to grow multiple crops. For instance, in 2018, only a quarter of small-scale farmers cultivated rice as compared to 65% and 93% of medium and large-scale farmers who harvested rice as a commercial crop and often maize as the second crop for home consumption. Moreover, as gathered from the individual interviews, the 2.5 tons/ha (maize) and 4 tons/ha (rice) yields obtained by large-scale farmers are almost triple that of small-scale farmers.

To mitigate crop risk failure, a land distribution system that allocates each farmer an irrigation field at both upstream and downstream areas is practiced in some FBLS including Harosha and Awadi Jitu in Ethiopia (Castelli *et al*. 2018; Mehari *et al*. 2013) and Chandia in Pakistan (van Steenbergen *et al*. 2010). This system has two main challenges: individual land ownership and land fragmentation. For instance, the Tana River large-scale farmers rejected the system during the FGDs, as they considered it a threat to their individual land ownership. It ceased to be operational in Tunisia because it caused land fragmentation: fields became too small to profitably cultivate (van Steenbergen *et al*. 2010). It is, however, an innovative system and should be duly considered in the Kenya government's 50,000 ha new FBLS development plans.

The *pastoral community,* are not familiar with the operational floodwater sharing arrangements. If their downstream grazing area annually receives two to three large floods, they consider this to have been a satisfactory flood season. Farmers also consider such irrigation turns to be sufficient for maize and rice crops respectively. The pastoralists indicated that they only had two satisfactory seasons in the past five years – they blame excessive floodwater use by farmers and the upstream dams.

4.1.2. Improvement measures for the traditional floodwater sharing system

Ostrom's 3rd Principle stipulates that adequately involving all those who will be affected in the decision-making process is imperative for successful improvement of existing floodwater governance rules (*upstream first*) or new rules.

Some 70% of the *small-scale farmers* identified improved floodwater sharing rules as their top priority followed by infrastructural development (24%) and weed and silt

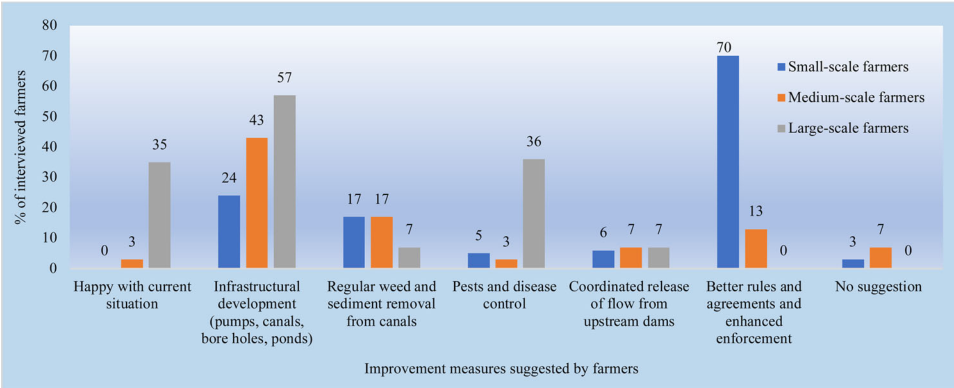

Figure 6. Tana River FBLS farmers' priority measures to improve effectiveness of floodwater sharing and distribution system (Source: interview data).

removal (17%) (Figure 6). *Upstream first* is the only operational rule in the study area. In its current form, the rule gives the predominantly large-scale upstream farmers absolute priority to irrigate as much as they want throughout the flood season. Three in four small-scale farmers explained that they would get sufficient floods if the upstream farmers do not excessively irrigate and cultivate multiple crops, a behavior they believe is encouraged by the *upstream first rule*. They suggested a modest modification: equally sharing the three-month flood period between upstream farmers on the one hand and the mid- and downstream farmers on the other. This is fairer, but still favors the upstream – a deliberate choice that attracted the support of large-scale farmers and is in-tune with Ostrom's 3rd Principle.

Upstream first is also common in the centuries-old Tihama Plain and Nari FBLS in Yemen and Pakistan respectively (Mehari, van Steenbergen, and Schultz 2007). Unlike in Tana River in Kenya, however, in these countries, supplementary rules were introduced that diluted the above discussed negative impacts of the upstream first rule: (1) *Rule on second turn*, which states that regardless of the location and size of a field and the social status of its owner, the field is entitled to a second turn only after all the other fields are irrigated once; and (2) *Rule on irrigation depth* in Yemen limits the amount a field receives during its turn to a "knee" height, about 50 cm depth.

There are also some FBLS in the Raya Valley in Ethiopia where *upstream first* is not practiced and fairer floodwater sharing arrangements are operational. Examples: (1) Harosha scheme: contribution to Operation and Maintenance (O&M) activities is a precondition to floodwater access (Castelli *et al*. 2018; Castelli and Bresci 2017); and (2) Guguf scheme: a lottery determines the floodwater allocation schedule (Mehari *et al*. 2013; Yazew *et al*. 2014).

Given the unpredictable and destructive nature of floodwater, and the interconnectivity of Tana River floodwater management structures, timely O&M is critical for all farmers to have improved access to floodwater. It should be a "responsibility" each and every farmer has to shoulder. This issue is not addressed by Ostrom's Principles, as these mainly advocate "meeting target beneficiaries' needs" without outlining the "responsibilities" beneficiaries have to fulfill.

A third of the *Large-scale farmers* are satisfied with the existing floodwater sharing system (Figure 6). Their priority is infrastructural development: 57% suggested the government should assist in the provision of pumps and construction of ponds to ensure irrigation during the non-flood (water scarcity) periods as well as the expansion of existing and the construction of new canals to optimize floodwater harvesting. Some 75% cited pests and diseases as a threat to crop productivity. As gathered from the field surveys, however, the pests and diseases problems appear to be linked with humidity caused by excessive flooding, which indicates a scope for large-scale farmers to reduce irrigation as current conditions are too wet. This excessive use of floods has already caused water logging and soil degradation.

Nearly 43% of the *Medium-scale farmers* agree with the large-scale farmers that infrastructure is the most important intervention to enable better access to sufficient floodwater. On the other hand, their second (weed and silt removal) and third (better floodwater sharing agreement) priority improvement areas, are akin to those of the small-scale farmers. However, the 13% of medium-scale farmers who supported the need for better floodwater sharing rules is significantly lower than the corresponding 70% of small-scale farmers (Figure 6).

From the above, it can be deduced that given their interest in robust irrigation infrastructure, large and medium-scale upstream farmers may be open to the idea of "linking" O&M to floodwater access. Such "linking" happened in Sheeb FBLS in Eritrea following infrastructural modernization that improved floodwater supply, but also required annual O&M, a task beyond the upstream farmers' financial capacity (van Steenbergen, Anderson, and Mehari 2011).

4.2. Conflicts and conflict mitigation process

Conflict is an issue that deserves attention in Tana River FBLS. A quarter of the interviewed small and medium-scale farmers witnessed, or were personally involved in, over 10 conflict events in 2018. In this same year, a third of large-scale farmers reported between 4 and 10 conflicts. Conflict here refers to all disagreements that require mitigation.

Unfair floodwater sharing accounts for nearly 70% of the conflicts. Downstream farmers angered by recurrent floodwater scarcity, which they blame on excessive upstream irrigation, attempt to block upstream canals and this initiates disputes. The other 25% of conflicts are land related, triggered by an encroachment of irrigated area by an upstream or downstream neighbor. The remaining 5% are caused by livestock trespassing that results in significant damage to agricultural land.

Given the unpredictable nature of floods, speedy conflict mitigation is imperative to ensure more efficient floodwater use. In recognition of this fact, Ostrom's 5th Principle recommends accessible, low-cost means for dispute resolution. Ostrom's 4th Principle further supports the case by avoiding harsh upfront penalties that may not find a receptive audience. It instead advocates for graduated sanctions: measured penalties for first-time offenses with a warning for higher retribution the second time around. These two Principles helped analyze the strengths and weaknesses of the conflict mitigation process in Tana River FBLS.

The process to address conflicts starts with "reconciliation efforts by neighbours" and this resolves most disputes within and between small and medium-scale farmers. Successful reconciliation ends with a verbal apology. The second stage, which often involves floodwater sharing related conflicts among large-scale farmers on the one hand and small and medium-scale farmers on the other, is handled by the "Council of Elders (CoE)." These are a group of ten respected retired elderly farmers (above the age of 55) who have over two decades of farming experience. The CoE-led mitigation process fulfills the requirements of Ostroms' 4th and 5th principles. It is affordable and accessible as the members of the CoE live within the farming community – lunch and refreshments are the only costs involved. It applies graduated sanctions, which start at about 10 USD and are doubled and quadrupled for second and third repeat offenders respectively. Nearly all decisions by the CoE are accepted and enforced.

The conflicts between pastoralists and farmers are usually handled by the local administration and there is no clear procedure here. Pastoralists are not an official party to the traditional floodwater governance system and do not abide by floodwater sharing rules that form the basis for the CoE-led conflict mitigation process. Thus, the CoE do not deal with pastoralists, a fact also evident in several other traditional FBLS (Mehari *et al*. 2013).

4.3. Institutional arrangements for floodwater sharing and distribution

In Tana River, like in almost all FBLS, various users with competing needs (farmers, pastoralists, hydropower dams) share intermittent basin water resources. Institutions with basin-wide outreach recommended by Ostrom's 6th Principle are, therefore, essential to safeguard that interventions at a certain location do not have unintended negative implications at another site within the basin.

From the FGDs and individual interviews, it was gathered that Irrigation Unit Committees are the only organizations currently operational in Tana River FBLS. They oversee floodwater sharing in an "irrigation unit" that serves a group of farmers sharing the same field canal. There are also village chiefs and community elders, but their mandate is limited to facilitating their fellow inhabitants' adherence to societal norms – they do not enforce floodwater sharing rules.

In the FGDs and individual interviews participating farmers overwhelmingly agreed that Ostrom's 6th Principle is relevant to their situation. As a priority, they suggested the establishment of a Tana River county Committee to ensure coordinated floodwater release from upstream dams, thereby mitigating the damage being caused to their standing crops. There are five upstream hydropower dams in Tana River (Muthigani 2011), which the farmers believe have reduced their floodwater supply. The Committee is expected to advocate against any further dam development programmes, in line with experiences elsewhere. For instance, in the Mekong delta, extensive upstream dam development has reduced flood flows and fluxes of fertile sediment crucial for fisheries and agricultural production in the flood plain (Ngoc 2017).

The farmers also suggested the establishment of two other committees: (1) Village Committees to enforce floodwater sharing rules, and O&M activities within and among villages; (2) Sub-county Committees: to coordinate these very same activities among the three Tana River sub-counties (Bura, Galole and Garsen). These Committees will be especially imperative if the Government implements its plans and develops FBLS in the upstream Galole and Bura sub-counties that have a combined potential of nearly 50,000 ha.

The DAL representatives engaged in the key informant interviews also recognized the importance of Ostrom's 6th Principle. They, however, stressed that a Tana River basin-wide institution can only be successful if farmers actively participate as members of the leadership alongside the local administration, and contribute their financial share to cover the operations of the institution. They further explained the reasons that have so far hindered the establishment of basin-wide institutions: (1) small-scale farmers have more pressing issues, such as ensuring sufficient harvest to feed their families; (2) large-scale and to some extent medium-scale farmers do not see the urgency, as they have not been as severely affected by floodwater scarcity as the small-scale farmers; and (3) government authorities largely ignored the Tana River FBLS as they considered it a marginal agricultural system. There is, however, renewed interest in FBLS following the recent mapping showing significant potential of the system (400,000 ha) across Kenya and 95,000 ha in Tana River county (Malesu 2019). Piloting in Tana River county, the Government plans to develop 50,000 ha under FBLS in the coming 5 years.

5. Conclusions

The paper analyzed the effectiveness of the traditional floodwater governance in Tana River FBLS across three key pillars: flood water sharing system; institutional arrangement; conflict mitigation. The analysis was conducted against the objectives set by the farmers while Ostrom's (2002) Governing the Commons Principles was used as a framework.

The traditional floodwater governance system does not meet the key objective of small-scale farmers: sufficiently irrigating their land and obtaining good harvests when floodwater is not physically limiting. These predominantly downstream farmers, who make up two-thirds of the farming households, have less than a 40% chance of receiving sufficient floodwater, even in relatively plentiful times. The main obstacle is the upstream first rule, which, contrary to Ostrom's 2nd Principle requirements, gives priority to large and medium-scale farmers throughout the three-month flood season. Two in three of the medium and large-scale farmers are also dissatisfied despite often sufficiently irrigating. Their main problem is inadequate infrastructure (canals, pumps, ponds), which they assert has limited their capacity to harvest good quality produce, especially during floodwater scarcity. In fact, their excessive irrigation during the flood season has caused water logging, soil degradation, and pests and diseases.

The institutional pillar is weak. Irrigation unit committees whose floodwater governance responsibility is confined to field canal level, are the only operational institutions. As suggested by the farmers, there is a need to establish relevant institutions at village, sub-county and Tana River county levels. This basin-wide institutional development advocated by Ostrom's 6th Principle could also reduce the damage being caused to standing crops by uncoordinated floodwater release from upstream hydropower dams.

The majority of farmers are satisfied with the Council of Elders (CoE) led conflict mitigation process, which is well-aligned with Ostrom's 4th and 5th Principles respectively: (1) it is affordable and accessible as the CoE members live within the farming community; and (2) it applies graduated sanctions: about 10 USD for first-time offending parties, which is doubled and quadrupled for second and third repeat offenders respectively.

There is renewed interest by the Kenyan government to invest in rehabilitation and expansion of FBLS in Tana River county and across the country. As is often the case in such investments, infrastructural development may be more appealing and prioritized, but this could inadvertently contribute to further upstream control. For increased equity, we recommend that fairer floodwater sharing systems and enforcing institutions be introduced prior to embarking on infrastructural development. To ensure sustainability, low-cost floodwater governance interventions that enhance the environmental services of FBLS while optimizing their agricultural and livelihood improvement contributions should be identified and introduced. This requires further research.

Finally, Ostrom's Principles provided a useful basis for analysis, but they have one major limitation. They advocate for "meeting target beneficiaries' needs" without outlining the "responsibilities" they have to fulfill. Given the unpredictable and destructive nature of floods, "timely operation and maintenance" is one such important "responsibility" in Tana River and other FBLS. Responsibilities may, however, only be assumed if benefits are expected, and this requires further development in the Tana River and other FBLS.

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